

CLAIMS

What is claimed as new and desired to be protected by Letters Patent of the United States is:

5 1. A semiconductor device, comprising:

 a semiconductor substrate including main and back surfaces and a
trimming opening penetrating therethrough from the back surface to the main
surface;

 an insulating film formed on the semiconductor substrate; and
10 a fuse element formed on the main surface of the semiconductor substrate
through the insulating film at a position facing the trimming opening.

 2. The semiconductor device as defined in Claim 1, wherein the
insulating film remains between the fuse element and the trimming opening until
15 a process of cutting the fuse element is performed.

 3. The semiconductor device as defined in Claim 1, wherein the
trimming opening is sealed from the back surface of the semiconductor substrate.

20 4. The semiconductor device as defined in Claim 1, wherein the
semiconductor device has a contour with a plurality of corner edges which are

rounded.

5. The semiconductor device as defined in Claim 4, wherein one of the plurality of corner edges has a curvature greater than those of others of the plurality of corner edges.

6. The semiconductor device as defined in Claim 1, wherein the contour of the semiconductor device has a side surface on which predetermined pits and dents representing a bar code are formed.

10

7. The semiconductor device as defined in Claim 1, wherein the back surface of the semiconductor substrate comprises at least one recess-shaped marking formed thereon.

15

8. The semiconductor device as defined in Claim 1, wherein the back surface of the semiconductor substrate comprises a marking formed thereon by laser irradiation.

20

9. A semiconductor device, comprising:
a semiconductor substrate including main and back surfaces and a trimming opening penetrating therethrough from the back surface to the main

surface;

an insulating film formed on the semiconductor substrate;

a plurality of fuse elements formed on the main surface of the semiconductor substrate through the insulating film;

5 a plurality of resistors; and

a resistor divider circuit configured to connect the plurality of fuse elements and the plurality of resistors and to output a voltage according to a resistor value determined by a number of fuse elements cut by a process of cutting the plurality of fuse elements.

10

10. A semiconductor device, comprising:

a semiconductor substrate including main and back surfaces and a trimming opening penetrating therethrough from the back surface to the main surface;

15

an insulating film formed on the semiconductor substrate; and

a voltage detecting circuit, comprising: a plurality of fuse elements formed on the main surface of the semiconductor substrate through the insulating film;

a plurality of resistors;

a resistor divider circuit configured to divide an input voltage, supply a

20

divided voltage, and connect the plurality of fuse elements and the plurality of resistors and to output a voltage according to a resistor value determined by a

number of fuse elements cut by a process of selectively cutting the plurality of fuse elements;

a reference voltage generating circuit configured to supply a reference voltage;
and

5 a comparator circuit configured to compare the voltage divided by the resistor divider circuit with the voltage generated by the reference voltage generating circuit.

11. A semiconductor device, comprising:

10 a semiconductor substrate including main and back surfaces and a trimming opening penetrating therethrough from the back surface to the main surface;

an insulating film formed on the semiconductor substrate; and

a constant voltage circuit, comprising:

15 a plurality of fuse elements formed on the main surface of the semiconductor substrate through the insulating film;

an output driver configured to control an output of an input voltage;

a plurality of resistors;

a resistor divider circuit configured to divide an output voltage, supply a
20 divided output voltage, divide an input voltage, supply a divided input voltage,
and connect the plurality of fuse elements and the plurality of resistors and to

output a voltage according to a resistor value determined by a number of fuse elements cut by a process of cutting the plurality of fuse elements;

a reference voltage generating circuit configured to supply the reference voltage; and

5 a comparator circuit configured to compare the voltage output by the resistor divider circuit with the voltage generated by the reference voltage generating circuit and control an operation of the output driver based on the comparison result.

10 12. A method of manufacturing a semiconductor device, comprising the steps of:

forming a fuse element on a main surface of a semiconductor substrate through an insulating film; and

forming a trimming opening from a back surface of the semiconductor substrate to
15 the main surface of the semiconductor substrate at a position facing the fuse element after a formation of the fuse element.

13. The method as defined in Claim 12, wherein the trimming opening is formed by anisotropic etching.

20

14. The method as defined in Claim 13, wherein the insulating film is

used as an etch stop layer.

15. The method as defined in Claim 13, wherein the semiconductor
substrate is cut into an individual chip simultaneously with a formation of the
5 trimming opening.

16. The method as defined in Claim 12, further comprising the steps of:
attaching a tape material on the main surface of the semiconductor
substrate; and
10 polishing the back surface of the semiconductor substrate,
wherein the forming step of the trimming opening forms the trimming
opening with the tape material attached to the semiconductor material.

17. The method as defined in Claim 12, further comprising the step of
15 marking on the back surface of the semiconductor substrate by laser irradiation
when laser marking is performed on the fuse element through the trimming
opening.

18. The method as defined in Claim 12, further comprising the
20 step of sealing the trimming opening.

19. The method as defined in Claim 18, wherein the sealing step seals the trimming opening with a resin material.